

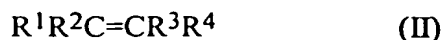
Claims

1. A process for the dihydroxylation of olefins by means of transition metal catalysts to prepare monofunctional, bifunctional or/and polyfunctional 1,2-diols of the formula I,



where

R<sup>1</sup> to R<sup>4</sup> are each, independently of one another, hydrogen, alkyl, CN, COOH, COO-alkyl, COO-aryl, CO-alkyl, CO-aryl, O-alkyl, O-aryl, O-CO-aryl, O-CO-alkyl, OCOO-alkyl, N-alkyl<sub>2</sub>, NH-alkyl, N-aryl<sub>2</sub>, NH-aryl, NO, NO<sub>2</sub>, NOH, aryl, fluorine, chlorine, bromine, iodine, NO<sub>2</sub>, Si-alkyl<sub>3</sub>, CHO, SO<sub>3</sub>H, SO<sub>3</sub>-alkyl, SO<sub>2</sub>-alkyl, SO-alkyl, CF<sub>3</sub>, NHCO-alkyl, CONH<sub>2</sub>, CONH-alkyl, NHCOH, NHCOO-alkyl, CHCHCO<sub>2</sub>-alkyl, CHCHCO<sub>2</sub>H, PO-(aryl)<sub>2</sub>, PO-(alkyl)<sub>2</sub>, PO<sub>3</sub>H<sub>2</sub>, PO(O-alkyl)<sub>2</sub>, where alkyl represents an aliphatic organic group having from 1 to 18 carbon atoms which may be linear, branched and/or cyclic and aryl is a 5-, 6- or 7-membered aromatic ring which contains from 4 to 14 carbon atoms and may be fused and contain from 0 to 3 heteroatoms such as N, O, S and where the alkyl and/or the aryl group may bear up to six further substituents selected independently from among hydrogen, alkyl, O-alkyl, OCO-alkyl, O-aryl, aryl, fluorine, chlorine, bromine, iodine, OH, NO<sub>2</sub>, NO, Si-alkyl<sub>3</sub>, CN, COOH, CHO, SO<sub>3</sub>H, NH<sub>2</sub>, NH-alkyl, N-alkyl<sub>2</sub>, PO-alkyl<sub>2</sub>, SO<sub>2</sub>-alkyl, SO-alkyl, CF<sub>3</sub>, NHCO-alkyl, COO-alkyl, CONH<sub>2</sub>, CO-alkyl, NHCOH, NHCOO-alkyl, CO-aryl, COO-aryl, PO-aryl<sub>2</sub>, PO<sub>3</sub>H<sub>2</sub>, PO(O-alkyl)<sub>2</sub>, SO<sub>3</sub>-alkyl, where alkyl and aryl are as defined above, characterized in that olefins of the formula II



where

$R^1$  to  $R^4$  are as defined above, are reacted with molecular oxygen in the presence of an osmium, ruthenium or manganese compound or a mixture thereof in water or a water-containing solvent mixture at a pH of from 7.5 to 13.

2. The process as claimed in claim 1 for preparing compounds of the formula I, characterized in that olefins of the formula II in which the substituents  $R^1$  to  $R^4$  are each, independently of one another, hydrogen, alkyl, CN, COOH, COO-alkyl, COO-aryl, CO-alkyl, CO-aryl, O-alkyl, O-aryl, N-alkyl<sub>2</sub>, aryl, fluorine, chlorine, bromine, iodine, CHO, CF<sub>3</sub>, NHCO-alkyl, CONH<sub>2</sub>, CONH-alkyl, NHCOO-alkyl, where alkyl and aryl are as defined above, are used.
3. The process as claimed in claim 1 or 2, characterized in that diols of the formula I in which  $R^1$  to  $R^4$  are each, independently of one another, hydrogen, alkyl, CN, COOH, COO-alkyl, CO-alkyl, CO-aryl, O-alkyl, O-aryl, aryl, fluorine, chlorine, bromine, CHO, NHCO-alkyl, where alkyl and aryl are as defined above, are prepared.
4. The process as claimed in any of claims 1 to 3, characterized in that the oxidant used is oxygen or a gas mixture comprising at least 15 percent by volume of oxygen.
5. The process as claimed in any of claims 1 to 4, characterized in that the catalyst used is an osmium, ruthenium or manganese compound.

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6. The process as claimed in any of claims 1 to 5, characterized in that the reaction proceeds at temperatures of from 20 to 200°C, preferably from 30 to 150°C, particularly preferably from 40 to 100°C, with the pressure being able to be up to 200 bar.
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7. The process as claimed in any of claims 1 to 6, characterized in that the amine added to improve the selectivity is a tertiary amine, preferably a bicyclic amine of the quinuclidine type.
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8. The process as claimed in any of claims 1 to 7, characterized in that the amine is introduced as a ligand.
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9. The process as claimed in any of claims 1 to 8, characterized in that sulfonamides such as methylenesulfonamide and/or carboxamides are added as cocatalysts.
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10. The process as claimed in any of claims 1 to 9, characterized in that the osmium compounds  $\text{OsO}_4$ ,  $\text{K}_2\text{Os}_2(\text{OH})_4$ ,  $\text{Na}_2\text{Os}_2(\text{OH})_4$ ,  $\text{Os}_3(\text{CO})_{12}$ ,  $\text{OsCl}_3$ ,  $\text{H}_2\text{OsCl}_6$ ,  $[\text{CF}_3\text{SO}_3\text{Os}(\text{NH}_3)_5](\text{O}_3\text{SCF}_3)_2$ ,  $\text{OsO}_4$  on vinylpyridine,  $\text{Bu}^t\text{NOsO}_3$ , the manganese compounds  $\text{MnO}_2$ ,  $\text{KMnO}_4$ ,  $\text{Ca}(\text{MnO}_4)_2$ ,  $\text{MnCl}_3$ ,  $\text{Mn}(\text{OAc})_3$  and the ruthenium compounds  $\text{RuCl}_3$ ,  $\text{RuO}_4$ ,  $\text{RuO}_2$  are used as catalysts and/or catalyst precursors.
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11. The process as claimed in any of claims 1 to 10, characterized in that the catalysts used are employed in amounts of from 0.2 to 0.00001 equivalents, based on olefin, preferably from 0.1 to 0.0001 equivalents and particularly preferably from 0.08 to 0.0005 equivalents.
12. The process as claimed in any of claims 1 to 11, characterized in that the ratio of amine to metal is from 0.01:1 to 1 000:1, preferably from 0.1:1 to 100:1, particularly preferably from 1:1 to 50:1.

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